WATER BALANCE AND FLUID CONSUMPTION IN THE SOUTHERN GRASSHOPPER MOUSE, *ONYCHOMYS TORRIDUS*

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Abstract.— Weight loss was rapid and fluid consumption decreased sharply when *Onychomys torridus* were exposed to salinities greater than 0.3 Molar. The southern grasshopper mouse is physiologically unspecialized for maintaining water balance in its xeric habitat. The southern grasshopper mouse is capable of weight maintenance on smaller daily water rations than is the northern grasshopper mouse (*Onychomys leucogaster*). Differences in the water balance of *O. torridus* and *O. leucogaster* may influence their local distributions in areas of sympatry.

Previous investigations of water balance in cricetid rodents have included limited information on the grasshopper mice of the genus *Onychomys*. Schmidt-Nielsen and Haines (1964) subjected *O. torridus* to several diets and to increasing concentrations of NaCl solution to test the species's ability to maintain water balance on various regimens. They used body weight maintenance as the criterion for demonstrating water balance. Boice (1972) presented limited data on daily water consumption in *O. leucogaster*, and he cited the lack of other water consumption data for the genus. This investigation was undertaken to partially fill that void and to provide additional information on the water balance of *O. torridus*.

Methods

Six southern grasshopper mice, *O. t. tularensis*, were obtained 18 km north of Reyes Station, San Luis Obispo County, California. The mice were taken to our laboratory and housed in steel laboratory cages (16.5 x 18 x 25.5 cm). A substrate of commercial mineral-type "cat litter" was provided. The temperature was controlled ($\bar{x}$=23 C; range 21-24 C), and the photoperiod was set to coincide with natural conditions. The mice were fed an unsupplemented diet of sunflower seeds *ad libitum* throughout the study.

Our experimental design was modified from that of Schmidt-Nielsen and Haines (1964) and McManus (1972). Water intake was measured using inverted graduated cylinders fitted with angled drinking tubes. A series of controls was used to correct for what little evaporation occurred. Daily fluid consumption was measured to the nearest 0.1 cc. All animals were weighed daily to the nearest 0.1 g.

The mice were exposed initially to *ad libitum* tap water for a three-week period, during which time their weights stabilized. Daily fluctuations of body weights between the second and third week on the tap water regimen were negligible. Salinity (NaCl) was then increased by 0.1 M every other week, from 0.1 M to 0.7 M. The mice were exposed to each successive saline solution for a period of one week. To allow for rehydration, they were given tap water for one week between each successive increase in molarity.

Results and Discussion

Mean body weight and fluid intake varied with increasing salinity (Fig. 1). After the initial stabilization period, weights showed an increase through 0.3 M and then declined sharply. Weight loss continued through 0.6 M, reaching a low value of 57 percent of the initial weights. Four animals died after exposure to 0.6 M NaCl, but two survived rehydration and died after two days' exposure to 0.7 M NaCl. The initial rise in body weight can be attributed to fluid retention. Beyond molarities of 0.3 M, weight loss was rapid, owing to dehydration and decreased food consumption.

Fluid intake increased sharply with exposure to salt concentrations up to 0.2 M. Consumption dropped slightly during exposure to concentrations of 0.3 M and 0.4 M and then dropped sharply through the period of exposure to concentrations of 0.6 M.

The rate of fluid consumption in *O.*

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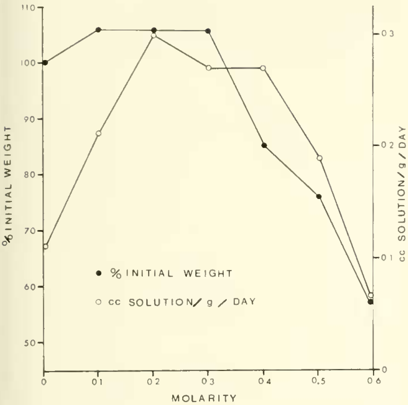

Fig. 1. Water intake and weight of *Onychomys torridus* as functions of NaCl molarity.

torridus showed an initial increase, and then a decrease, probably an avoidance reaction, as McManus (1972) reported for the chinchilla (*Chinchilla laniger*). This initial increase in fluid consumption probably meant that as the kidneys came closer and closer to reaching maximum limits of concentrating capacity, more and more saline water was required from which to extract the same volume of physiologically useful water. Possibly the decrease in fluid consumption at concentrations greater than 0.3 M is attributable to the unpalatability of concentrated salt solutions, as McManus (1972) suggested.

These data indicate that *O. torridus* is an effective osmoregulator when exposed to NaCl concentrations up to and including 0.3 M. Beyond that point, the species is not able to maintain water balance, and it may be unable to survive prolonged periods of exposure to solutions greater than 0.4 M. These results are similar to those reported by Schmidt-Nielsen and Haines (1964). On a diet of laboratory chow and with increasing salinity of the drinking water, all of their *O. torridus* maintained weight on 0.2 M NaCl. Four of the six mice maintained weight on 0.3 M NaCl, and all mice lost weight rapidly on 0.4 M NaCl solution.

Initial rates of consumption of tap water in *O. torridus* allow a comparison with the data of Boice (1972) for *O. leucogaster*. Five mice in this study averaged 0.23 cc/g/day after 20 days. *O. torridus* averaged 0.11 cc/g/day after three weeks. Although possible differences in humidity in the two laboratories were not reported, these data suggest that *O. torridus* is capable of weight maintenance on smaller daily water rations than is *O. leucogaster*. The possibility that differences in the water balance of *O. torridus* and *O. leucogaster* influence their local distributions in areas of sympatry lends itself to further investigation.

The efficiency of *O. torridus* in maintaining body weight on concentrations of NaCl solutions is similar to those of some other myomorph rodents that have been investigated, including *Neotoma micropus* and *Neotoma floridana* (Birney and Twomey, 1970), *Microtus ochrogaster* and *Microtus pennsylvanicus* (Getz, 1963, 1966), *Peromyscus floridanus* (Fertig and Layne, 1963), and *Rattus norvegicus* (Adolph, 1943). All these species lost weight or died at concentrations of 0.3 M NaCl or greater.

The data in our study support the conclusion of Schmidt-Nielsen and Haines (1964) that *O. torridus* is physiologically unspecialized for maintaining water balance in a xeric environment. We concur that the southern grasshopper mouse is adapted to its xeric environment by its carnivorous diet, which provides sufficient moisture for the species to maintain its water balance.

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